Cost Effective Internet Access and Video Conferencing for a Community Cancer Network

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Utilizing the ubiquitous personal computer as a platform, and Integrated Services Digital Network (ISDN) communications, cost effective medical information access and consultation can be provided for physicians at geographically remote sites. Two modes of access are provided: information retrieval via the Internet, and medical consultation video conferencing. Internet access provides general medical information such as current treatment options, literature citations, and active clinical trials. During video consultations, radiographic and pathology images, and medical text reports (e.g., history and physical, pathology, radiology, clinical laboratory reports), may be viewed and simultaneously annotated by either video conference participant. Both information access modes have been employed by physicians at community hospitals which are members of the Jefferson Cancer Network, and oncologists at Thomas Jefferson University Hospital. This project has demonstrated the potential cost effectiveness and benefits of this technology.

INTRODUCTION

Collaborative associations of academic medical institutions and community hospitals aid cancer research and treatment. These associations are mutually beneficial. The physicians at the community hospitals gain access for their patients to state of the art cancer treatment procedures, while providing research medical centers with a wider pool of patients for clinical trials. One such association, the Jefferson Cancer Network, links the Thomas Jefferson University's Cancer Center with seven community hospitals in the Philadelphia metropolitan area. These collaborative patient care and clinical research efforts require consultation between the academically-based oncologists and the community-based physicians. The need for these consultations regarding individual patients arises not merely from a normal sharing of medical expertise between physicians, but also from the complex, detailed protocol eligibility and treatment requirements which must be followed.

The geographical separation between the cancer network hospitals is a barrier to holding these conferences. Having one physician travel to another's hospital is a time-consuming approach to physician consultations. The commonplace alternative to physically meeting is, of course, telephone consultations. However, telephone conferences are limited by the inability to interactively discuss visually oriented patient clinical data, such as radiographs. A "high tech" approach to these remote consultations is video conferencing, in which the voice communication of the simple telephone call is augmented by simultaneous video transmission of "live" images of the conference participants and any materials (*e.g.*, radiographs, pathology slides) present at either location. As with many other "high tech" approaches, the cost and complexity of video conferencing has often made it an unsatisfactory solution to medical consultation.

The goal of this project is to implement a cost-effective video conferencing system for medical consultations between oncologists at the Jefferson Cancer Center (JCC) and community hospital members of the Jefferson Cancer Network (JCN). These consultations will facilitate access for the patients of these community physicians to the best cancer treatment. The implementation of such a telemedicine system for these consultations is only realistic if it is maintainable and cost-effective, particularly from the perspective of the community hospital. This paper describes the design of and initial experiences with a computer system for Internet access and video conferencing that meets these practical objectives.

SYSTEM DESIGN

This project required integrated hardware and software which would be capable of providing Internet access and video conferencing for physicians at geographically separate hospitals in the Philadelphia metropolitan area. Internet access had to be sufficiently responsive so that the users did not perceive the transmission of graphics as unduly slow. The video conferencing capability had to allow for simultaneous display and annotation of image files by the participants at either end of a video conference. Practical considerations dictated that the workstation platform deployed at the community hospitals be low-cost and maintainable by existing staff at the remote hospitals. Early discussions with JCN

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member hospital representatives led to a targeted maximum system cost of $5,000 for each video conferencing workstation, and an overall hospital investment of less than $10,000. Both Internet and video conferencing applications are available on several low-end UNIX/RISC workstations. However, these platforms were rejected because of their price exceeded the $5,000 workstation limit. Also, a lack of familiarity with these UNIX platforms among the data processing staffs at the community hospitals made the possibility of local in-house system support questionable.

Video conferencing systems are also available for the ubiquitous personal computer (PC) platform. These systems had total hardware and software costs below our target maximum, and were technically very familiar to our colleagues at the remote hospitals (Intel chip based PC's running Microsoft *Windows* being widely used at these institutions). After surveying the available PC video conferencing products, price and technical considerations led us to choose *ProShare* and *Remote Express* from Intel Corporation. The former product is used for video conferencing, while the latter, for Internet Protocol (IP) access. Both these products use Integrated Services Digital Network (ISDN) for communications between sites.

While ISDN is not high-bandwidth, it is suitably priced and has wide availability, as well as the ability to satisfy the video and data transfer requirements of this project. ISDN is a mid-bandwidth communications technology which utilizes existing digitally-switched public telephone networks [1]. This service is tariffed at very low rates compared to other mid- and high-bandwidth connection modes (*e.g.*, in Pennsylvania the current tariff is $40 per month, and $0.05 per usage minute for a Basic Rate Interface -- two bonded 64-Kbit channels). It does not require fiber optic cable, allowing its use in any hospital, office, or home over the existing copper telephone wiring. In the mid-Atlantic states, ISDN service is universally available, since the local telephone operating company will route calls via other central offices if the local central office has not yet been upgraded to digital switching. ISDN also offers flexible connectivity, since it is "switchable" to any other ISDN system by dialing that systems' number, rather than being limited to a prearranged "point-to-point" line. With video compression, two channel ISDN is capable of at least 12 frames per second video display rates. Considering that the video consists primarily of "talking heads," and that the video window is typically 2.0 inches by 1.5 inches (maximum size is 4 inches by 3 inches), the compressed ISDN video rate provides satisfactory video. Likewise, ISDN can transfer a 512x512 pixel CT image uncompressed in about 18 seconds -- with non-lossy compression this transfer time can be reduced to under 10 seconds. Graphic files typically found on Internet pages are also transferred at acceptable rates.

The IP access to the World Wide Web (WWW) [2] was chosen for accessing medical information (concerning clinical trials, etc.) because of the ease of establishing and maintaining the computerized information sources, and the availability of viewers (*i.e.*, browsers) for various operating systems, such UNIX, Microsoft's Windows, and Apple's System 7. The information to be presented is primarily interrelated text, with some images. The text files are readily converted to the hypertext markup language (HTML) used with Internet pages. This process will become easier in the near future as major word processing software vendors provide HTML converters. The WWW is being increasingly used as a medical information resource, including even an investigation of its suitability for disseminating digital image teaching materials [3]. Providing Internet connectivity to the community hospitals provides them with this access to the multitude of other information sources around the world.

IMPLEMENTATION

Physicians at the community hospitals rely on the Jefferson Cancer Center World Wide Web "home page" (*http://www.jci.tju.edu*) to obtain information on available cancer clinical trials. Once a physician has identified a cancer patient as a possible candidate for a clinical trial, then a video conference is arranged to discuss the patient's diagnosis and eligibility for that treatment.

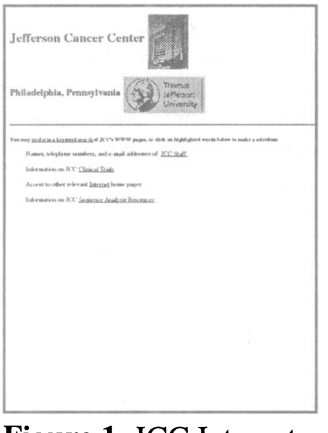

Figure 1. JCC Internet home page.

As shown in Figure 1, the JCC Internet home page provides a path to a list of Cancer Center staff (with a direct means of sending them electronic mail), access to clinical trials information, links to other oncology-related Internet home pages, and a listing of other

JCC resources. If "clinical trials" is selected, the page shown in Figure 2 is displayed. In addition to a further list of selections are three "clickable maps" of the anatomy, allowing selection of a specific cancer site of interest by "clicking" on the appropriate part of the anatomy (*e.g.*, lung, breast, head and neck, gastrointestinal).

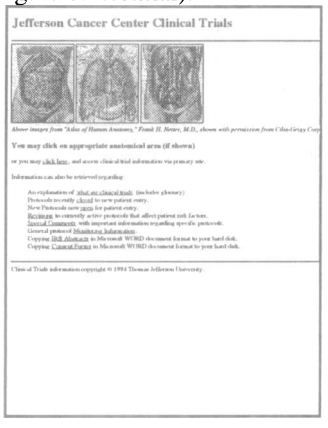

Figure 2. "Clinical Trials" page.

The Intel *ProShare* software provides the framework for establishing the ISDN video conference link and displaying the patient data to be discussed. When a physician at a JCN hospital has a patient he wishes to discuss with a staff member at JCC, he will assemble a "meeting" file on the video conferencing PC at his hospital, using the *ProShare* software. This meeting file is a collection of text or image files, containing patient data such as history and physical reports, pathology, clinical laboratory, and radiology reports, and scanned radiographic films and pathology slides (or photographs). If the text reports are already available as word processing computer files, the scanning of these documents is not necessary. Likewise, should computer files exist of the radiographic studies (*e.g.*, CT's, MRI's), they can be included in the meeting files (after conversion from radiographic vendor image formats), and film need not be scanned. The assistance of radiologists and pathologists may be needed to identify pertinent images for the video conference. They may also desire to be present during the conference. The actual film and document scanning can be performed by clerical staff.

Once a video conference call has been established, the conference participants can see each other in small video windows (up to 4 inches by 3 inches). Standard speaker phone audio is also provided using small microphones and speakers. Medical reports and images, from the meeting file, are displayed on the *ProShare* "whiteboard" window. Annotation of anything on the whiteboard is possible using drawing tools, such as marker pens, "highlighters," keyboard text, and geometric shapes (squares, circles, lines). The annotation may be made by either participant, with the contents of the whiteboard being continuously updated on both sides. Figure 1 shows a typical video conference screen.

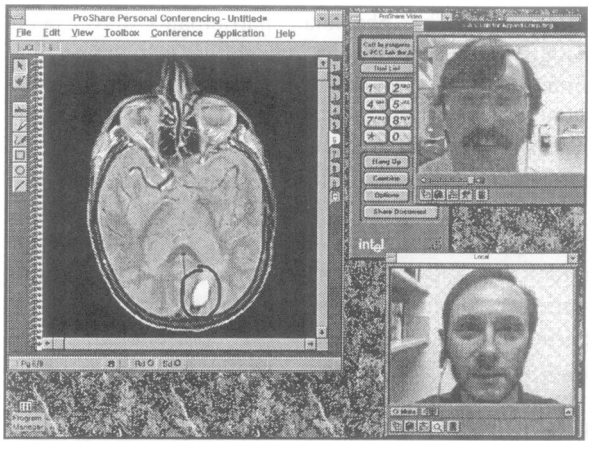

Figure 3. PC video conference, showing the "whiteboard" and an MRI image with a circled tumor.

EXPERIENCE

At this time, four video conferencing PC workstations have been installed on the Thomas Jefferson University (TJU) campus, and fifth video conferencing PC at Lower Bucks Hospital in Bristol, Pennsylvania (about 20 miles from Philadelphia). The remaining six JCN hospitals are scheduled to have systems installed over the next twelve months.

Frequent use has been made of the Internet access to clinical trials information. Maintenance of this information on the World Wide Web has been automated to a large degree by the JCC computer staff. The TJU clinical trials support office provides word processing documents which are then converted to Hyper Text Markup Language (HTML), which can be displayed by Web browsers such as the National Center for Supercomputing Applications' *Mosaic* [4]. Software was developed to automatically convert clinical trials information from the Eastern Cooperative Oncology Group (ECOG) directly into HTML. ECOG provides us with rigidly formatted text files. We wrote a "C" language program to read the files and rewrite them with the desired HTML tags inserted. Our experience has been that unless the preparation of the information offered by a Web site can be automated to a large degree, maintenance can become overwhelmingly time consuming.

A few video conferences have been held to date. The performance of the technology has been very satisfactory. The transfer of meeting file patient data over ISDN occurs with sufficient speed. The video frame rates (between 12 to 15 frames per second) are

adequate. The physician participants have been enthusiastic, appreciating the ability to concurrently annotate images on the whiteboard while conversing with and seeing each other. Furthermore, these initial conferences suggest that the whiteboard interaction is of greater importance to the participants than the "talking heads" video windows. While "seeing" the other person seems to add a nice ambiance to the interaction, the quality of the video image (resolution, size, frame rate) is of secondary importance to the participants than the quality of the presentation of the information displayed on the whiteboard.

It should be noted that the radiographic images are displayed in these video conferences along with the text of the radiologist's interpretation. These images (as well as those of the pathology slides) are part of the patient data being presented for *review* -- it is not the intent that diagnostic interpretations be formulated from these images. As has been noted [5], the quality of the image presentation of these PC systems is satisfactory for these consultations.

We have found that the major area of work to be done with video medical consultations lies not with the technology involved, but rather with the human engineering of how to prepare a video medical conference. To be successful, these video consultations must not involve an additional preparation effort of such magnitude that it would outweigh the benefits that this consultation modality offers over simple telephone calls. A number of questions remain to be answered: Which patient data are pertinent to the discussion of a specific patient's treatment? Should certain patient data selections be made by the specialist (*i.e.*, radiologist, pathologist), rather than the attending physician? Should these other physicians be present for the video conference? How should the information be organized? What software tools are needed to easily navigate through the mass of clinical information? It is this organizational infrastructure that needs to be fully developed so that these video medical consultations can occur efficiently.

CONCLUSIONS

The Internet offers a very effective means of providing medical information to clinicians. Browsers exist for all major platforms, and the preparation of the information content is becoming increasingly more efficient. ISDN is a suitable, cost effective communications mode for both IP access and medical video consultations. Personal computers are a low cost platform capable of providing both Web access and video conferencing. While higher bandwidth technologies will without doubt be commonplace and cost effective in the future, ISDN with PC's are available for these applications today. With these tools, focus can be placed on defining the human engineering aspects of efficient remote medical conferencing.

References

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